CIVIL AERONAUTICS BOARD

AIRCRAFT ACCIDENT REPORT

ADOPTED: June 2, 1966 **RELEASED:** June 9, 1966

UNITED AIR LINES, INC.
VICKERS VISCOUNT 745D, N7405
NEAR PARROTTSVILLE, TENNESSEE
JULY 9, 1964

SYNOPSIS

A United Air Lines, Inc., Vickers Viscount 745D, N7405, Flight 823, crashed 2-1/4 miles northeast of Parrottsville, Tennessee, at 1815 e.s.t., July 9, 1964. Thirty-four passengers and the four crewmembers died in the crash. One passenger died of injuries following a free fall from the aircraft before the crash. The aircraft was destroyed by fire and impact damage.

Flight 823 was a regularly scheduled operation from Philadelphia, Pennsylvania, to Huntsville, Alabama, with en route stops at Washington, D. C., and Knoxville, Tennessee. The flight operated without any reported discrepancies or difficulties until approximately 1810 e.s.t., when it was observed flying at low altitude trailing smoke. The flight continued in a southwesterly direction and at a point approximately 1.6 nautical miles before the impact site, a passenger was seen falling from the aircraft, and a short time later a cabin window was seen falling. The aircraft was then observed going into a nose-high attitude, the left wing and the nose went down, and the aircraft dived into the ground, exploded, and burned.

The Board determines that the probable cause of this accident was an uncontrollable inflight fire of undetermined origin, in the fuselage, which resulted in a loss of control of the aircraft.

1. INVESTIGATION

1.1 History of Flight

The aircraft, N7405, operated as United Air Lines (UAL) Flight 609 from Raleigh-Durham, North Carolina, to Philadelphia with intermediate stops at Washington, D. C., Buffalo and Elmira, New York, and Williamsport, Pennsylvania. The aircraft departed Raleigh-Durham at 0705[1/] and arrived at Philadelphia at 1245. The captain and senior stewardess of the flight from Buffalo to Philadelphia stated that the flight was routine and the aircraft operated normally.

1/ All times herein are eastern standard time based on the 24-hour clock.

The captain, first officer, and one stewardess served aboard UAL Flight 662 from Washington, D. C., to Philadelphia, Pennsylvania, arriving at Philadelphia at approximately 1215.

United Air Lines Flight 823, a Vickers Viscount 745D, N7405, departed Philadelphia at 1513 arriving at Washington, D. C., at 1554. No discrepancies were reported by the crew at Washington and no maintenance, other than servicing, was required or performed prior to departure for Knoxville.

Flight 823 was a regularly scheduled domestic public transportation flight from Philadelphia, Pennsylvania, to Huntsville, Alabama, with intermediate stops at Washington, D. C., and Knoxville, Tennessee. Flight 823 departed Washington, D. C., at 1636 with an estimated arrival time of 1813 at Knoxville, Tennessee.

An Instrument Flight Rules (IFR) flight plan, filed for Flight 823 from Washington to Knoxville, requested routing via Victor Airways 143, 140, and 16 at an altitude of 14,000 feet m.s.l. Following departure from Washington with 35 passengers and a crew of four,[2] the flight operated without any reported difficulties to the Holston Mountain VOR.[3] The crew reported to the Atlanta Air Route Traffic Control Center (ARTCC) over that fix at 1758:35 and estimated their arrival at Knoxville at 1821.

Approximately one minute after having reported passing Holston Mountain, the crew[4] requested a clearance to descend to the lowest available altitude. They were cleared to descend to and maintain 8,000 feet. Three minutes later the crew cancelec their IFR clearance. The controller offered to pass control of the flight to Knoxville Approach Control when they were closer in and advised they could stay on the Center frequency. At 1802:55 the crew responded to this transmission with "OK." This was the last known transmission from the aircraft.

The aircraft's radar target disappeared from the controller's scope at 1813:30. At 1814, after waiting four sweeps of the radar antenna, the Atlanta controller called the aircraft to advise them he had lost radar contact but he received no reply.

Numerous ground witnesses observed the aircraft flying at what they considered to be a very low altitude. Witnesses estimated the altitude of the aircraft to be from 200-500 feet above the ground along a line generally parallel to, but south of, V16. The last 10 to 12 miles of the flightpath were observed by a number of ground witnesses, several of whom stated they saw smoke of varying density apparently coming from the fuselage of the aircraft.

Flight 823 was first observed approximately 38 miles southwest of Holston Mountain VOR at an estimated altitude of 5,000 feet descending. There was no visible difficulty at that time. A witness who observed the aircraft from a position 11 miles

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2/ A second stewardess boarded the aircraft at Washington for the trip to Huntsville.

3/ Holston Mountain VOR is located 92 nautical miles east-northeast of Knoxville VORTAC on Airway V16.

4/ The copilot's voice was identified as making the radio transmissions after passing Holston Mountain.

northeast of the crash site was the first to report seeing anything unusual. She noted a violet red light burning on the fuselage. She could offer no further clarification as to the location of this light. While she could read the company name on the side of the aircraft, she did not see any smoke. The time was about 1810 and the aircraft was estimated to be at an altitude of 500 feet.

The first witness to report smoke from the aircraft was approximately five miles from the crash scene. He stated that ". . . smoke was coming out of the tail part . . ." and ". . . there were brown spots like the paint was off of it about half way back on the body. . . ." Witnesses about one mile farther along the flight-path did not observe anything unusual, except the low altitude, until the aircraft had passed them at which time they observed smoke coming from the aircraft.

A number of witnesses about two miles from the crash site, near the flightpath, did observe black smoke coming from the aircraft fuselage near the wings. A large black object, later identified as a passenger, was observed to fall away from the aircraft, followed by dense black smoke. The witnesses stated that the object did not strike the tail of the aircraft after coming out the left side over the wing. Farther along the flightpath a bright object, later identified as the left No. 9 emergency cabin window, fell from the aircraft. Heavy smoke was seen continuing to come from the aircraft.

While the majority of the witnesses did not report seeing any fire, some witnesses did report signs of fire in or on the aircraft.

Shortly after the passenger and the window fell from the plane the aircraft nosed up, the left wing went down, the aircraft nosed down and crashed into a rocky wooded hillside.

The crash occurred approximately 41 nautical miles east-northeast of the Knoxville VORTAC and about 2-1/4 nautical miles northeast of Parrottsville, Tennessee,[5/] at approximately 1815. The accident occurred during daylight hours at an elevation of approximately 1,400 feet m.s.l.

1.2 Injuries to Persons

The four crewmembers and 34 passengers were killed in the crash. One other passenger died of impact injuries after a free fall from the aircraft, landing about 1.6 nautical miles from the crash site.

1.3 Damage to Aircraft

The aircraft was destroyed by impact and fire damage.

1.4 Other Damage

Private property damage was confined to burned trees and ground cover.

5/ 83 03' 41" west - 36 01' 36" north.

1.5 Crew Information

Captain Oliver E. Sabatke, 41, held airline transport pilot certificate No. 479853 with ratings in DC-3, DC-3S, DC-6/7, Lockheed Constellation, and Vickers Viscount. His last Viscount proficiency training was completed June 30, 1964, in the Viscount simulator. His last physical examination was completed April 4, 1964, with no limitations. He had a total of 15,665 hours flying time including 1,700 hours in the Viscount. His original checkout in Viscount aircraft was May 18, 1957. Captain Sabatke had a 24-hour off duty period prior to his first flight on July 9, 1964, and had been on duty 6:19 hours at the time of the accident.

First Officer Charles L. Young, 37, held airline transport pilot certificate No. 721324 with a Vickers Viscount rating. He passed a first officer's proficiency check in the Viscount February 7, 1964, and his last en route check July 7, 1964. His last physical examination was completed January 14, 1964, with a limitation attached that "Holder shall wear correcting glasses while exercising the privileges of his airman certificate." He had a total of 7,715 hours flying time including 2,100 hours in Viscounts, and had passed a type rating check in the Viscount February 14, 1963. He had a 25-hour rest period before reporting for duty July 9, 1964, and had been on duty 6·19 hours at the time of the accident.

Stewardess Carole L. Berndt, 21, was employed by United Air Lines, Inc., February 14, 1963. She had completed her last recurrent training May 12, 1964, and had 14·08 hours rest period before the flight.

Stewardess Virginia K. Vollmer, 22, was employed by United Air Lines, Inc., March 11, 1964, and completed her last competency check April 20, 1964. She had an 18:04-hour rest period prior to this flight.

1.6 Aircraft Information

N7405, a Vickers Viscount 745D manufactured November 14, 1955, with manufacturer's serial No. 103, was owned by United Air Lines, Inc. The airframe had flown 23,804 hours and had undergone a numbered inspection (#2) 180 hours before the accident. The aircraft received a preflight check six hours before the accident and was given an en route preflight inspection just prior to takeoff from Washington.

The aircraft was powered by four Rolls Royce model Dart 510 engines equipped with ROTOL Ltd. propellers model R130/4-20-4/12E with RA 25842 blades installed. Total times of engines and propeller hubs were:

Engine No.	Total Time (TT)	Time Since Overhaul (TSO)
1	19,003:18	2,491:30
2	17,817:29	3,718:05
3	17,689:59	3,585:08
4	19,525:30	2,438:23

Propeller No.	Total Time (TT)	Time Since Overhaul (TSO)
1	19,005:27	2,437:30
2	2,896:32	2,896:32
3	19,333:06	1,003:45
4	21,137:37	2,438:23

All the propeller blades had the same TSO as their hubs. The TT on the blades of Nos. 3 and 4 propellers were identical with their hubs but the total time of the blades on No. 1 propeller was 15,312:58 and on No. 2 propeller was 20,376:28.

A review of the maintenance records revealed there were no known discrepancies when the aircraft left Washington. The records indicated that N7405 was maintained in accordance with existing United Air Lines, Inc., and FAA approved directives with the exception of the deletion of a turbine blade inspection of No. 2 engine during the last block overhaul, and a similar deletion of an intercooler air inlet cleaning operation. The aircraft and powerplants were reported to be airworthy at the time of departure from Washington.

The takeoff weight of Flight 823 was 58,948 pounds and the weight was estimated to be 51,468 pounds at the time of the crash. Maximum allowable takeoff weight for runway 33 at Washington National Airport was 60,600 pounds. The center of gravity (c.g.) limits for the flight were 9 percent Standard Mean Chord (SMC) forward and 26 percent SMC aft. The aircraft was within these limits at takeoff and was computed to be within limits at the time of the crash.

The aircraft was loaded with 10,900 pounds of Jet A[6/] at takeoff and was computed to have 6,327 pounds of fuel aboard at the time of the crash.

1.7 Meteorological Information

The United States Weather Bureau (USWB), Washington Office, issued an aviation area forecast at 1345 valid for 12 hours beginning at 1400, which included Washington D. C., eastern North Carolina, and Virginia. A trough was reported extending southwestward from a low off the New Jersey coast. Throughout the area clouds were forecast at 3,000 feet scattered variable to broken; ceilings 10,000 feet broken variable to overcast; scattered ceilings of 1,500 feet broken, 5,000 overcast; visibility two miles in light rain, showers, or thunderstorms with light rain showers; becoming 3,000 feet scattered, ceilings 12,000 broken and eight miles visibility by 2200. Thunderstorms were forecast to be more numerous in West Virginia through western Virginia and western North Carolina. The freezing level was forecast to be 11,000 to 12,000 feet with brief moderate, possibly heavy icing above the freezing level in heavy showers and thunderstorms. Brief severe turbulence was forecast to be likely in thunderstorms.

The USWB office at Memphis forecast squall line thunderstorms over western Tennessee from 1500 to 2100. Central and eastern Tennessee were forecast to have ceilings at 2,000 to 3,000 feet broken, variable to scattered, 10,000 overcast variable to broken with layers merging and tops to 40,000 feet and, in scattered thunderstorms and heavy rain showers, ceiling 500 feet overcast, visibility one mile. Heavy mixed icing was forecast in thunderstorms above the freezing level at 12,000 to 13,500 feet.

The Knoxville terminal forecast issued by USWB Memphis at 1145 valid for 12 hours beginning at 1200 called for scattered clouds at 3,000 and 30,000 feet with a chance of a thundershower.

6/ Standard Kerosene turbine engine fuel.

The crew was provided with the latest available weather sequence reports for their route before departure from Washington.

The ground witnesses reported that the weather in the accident area, and along the last segment of flight from Holston Mountain, was clear and calm, with a few high scattered clouds. The accident occurred in day VFR conditions about 1:40 before sunset.

1.8 Aids to Navigation

There were no reported discrepancies of ground or airborne navigation equipment during the flight. The aircraft came under radar observation and control of the Atlanta Air Route Traffic Control Center at 1735. Both primary and secondary radar targets[7] were observed until they disappeared at 1813:30, some 15 minutes after passing Holston Mountain VOR. The center's radar had been flight checked as usable down to 6,000 feet m.s.l. along Victor 16 from Holston Mountain VOR to the Ottway Intersection 39 miles southwest of the VOR. Radar beacon targets had been observed along this portion of Victor 16 down to an altitude of 4,000 feet m.s.l. The last altimeter setting given the crew of Flight 823 was 29.87 inches for Knoxville by Atlanta Center.

The Knoxville VORTAC was operational during the period Flight 823 was flying between Holston Mountain and Knoxville.

1.9 Communications

There were no reported discrepancies in air to ground communications during the flight from Washington to Holston Mountain.

The flight was observed on radar to pass Holston Mountain VOR at 1757. The crew called at 1758:35 and reported passing Holston Mountain at 1758. At 1759:45 the flight requested the "lowest altitude available" and was cleared to descend to and maintain 8,000 feet. At 1802:45 the flight canceled their IFR clearance. At that time the Atlanta controller offered to hand the flight off to Knoxville Approach Control when it got a little closer in, if they would stand by on the Center frequency. At 1802:55 the flight acknowledged this transmission with "OK." This was the last known transmission from the flight.

At 1814:10 the Atlanta controller called the flight to report his loss of radar contact but received no reply. All other attempts by him to contact Flight 82[illegible] were fruitless.

There was no evidence of an emergency or any unusual situation in any transmission by the crew.

1.10 Aerodrome and Ground Facilities

Not involved in this accident.

7/ Primary radar targets are reflections from the aircraft surfaces. Secondary radar targets are electronic returns from a radar transponder aboard the aircraft.

1.11 Flight Recorder

The aircraft was equipped with a Lockheed Aircraft Service model 109C flight recorder, serial No. 578. The recorder was installed in the electrical compartment below the cabin floor at fuselage station (FS) 389.8/ The recorder shell was crushed to one-half its original diameter and had separated due to shear loads. The contents were exposed to fire which destroyed the aluminum recording tape. No usable information was available. This is the first recorded instance of the destruction, by fire, of recording tape in a Lockheed recorder.

1.12 Wreckage

The aircraft struck on a 45-degree, heavily wooded slope at an elevation of approximately 1,400 feet m.s.l. The heading on impact was 135 degrees, the nose was approximately 55 degrees below the horizon, and the bank angle was about 45 degrees left wing down. The wreckage, except the No. 9 emergency window and some small pieces from the cabin interior, was contained in an area 300 feet long and 200 feet wide.

A 1/2 to 3/4 mile wide ground search was conducted for 5-1/2 miles back along the flightpath from the impact site. The No. 9 emergency window, scraps of cloth from the cabin interior, an emergency exit placard, and parts of a window seal were located 2,320 feet, on a magnetic bearing of 035 degrees, from the primary wreckage site. The cabin material was scattered over an area which extended about 600 feet from the window. The free-fall victim was located 8,400 feet, on a magnetic bearing of 030 degrees, from the primary wreckage site. A cigarette lighter with a clear plastic fuel reservoir 7/8 full was found near the body. No other material from the aircraft was found along the flightpath.

The aircraft wreckage was fragmented and severe ground fires burned for several hours after the accident. All major components were accounted for at the accident scene and there was no evidence of pre-impact structural failure. The landing gear and flaps were retracted. The primary flight control trim settings were: aileron, one degree right wing down; elevator, one degree nose down; and rudder, 3/4 degree, nose right.

The engines were rotating with the propeller blade angles in the flight range at the time of impact. The powerplants revealed no evidence to suggest failure or maloperation.

The hydraulic and electrical systems components, including lines and wiring respectively, were extensively damaged by impact and, in part, destroyed by fire. However, an examination of the pieces that were recovered did not reveal any evidence of system failure or malfunction. One electrically operated fuel boost pump and the NESA inverter showed rotational damage.

The flight control system utilizes push-pull rods beneath the cabin floor, located to the left of the fuselage centerline. Except for terminal ends and some steel sections, these rods are made of aluminum. Portions of the aluminum material were destroyed by fire.

8/ Fuselage stations (FS) are measured in inches from a zero datum point at the nose of the aircraft.

Despite impact and fire damage, some information was obtained from the navigation and communications equipment. The two VHF radio transmitter selector switches were positioned on "No. 1 VHF Com." The No 1 VOR navigation receiver was tuned to the Knoxville VORTAC. The No. 2 VOR receiver could not be identified. The omni bearing indicators read 066 and 148 degrees. The cockpit control head of the Air Traffic Control (ATC) radar beacon transponder was recovered positioned on Channel 11, Mode B; however, the Atlanta ARTCC radar had been receiving Channel 11, Mode A. Of the two automatic direction finding loop antennas, only one provided bearing information, 096 degrees. The distance measuring equipment (DME) as recovered was tuned to the Knoxville VORTAC with the mileage module locked at 47.5 miles. One altimeter was recovered, set at 29.82.

1.13 Fire

Both inflight and post impact fire occurred in this accident. The extent of the post impact fire as well as the extensive break-up hampered the investigation with respect to origin and progress of the fire. However, a comprehensive mock-up did permit some determinations in these regards.

Ground witnesses established by observations of smoke that there was an inflight fire. Burns and soot deposits on the free-fall victim and fire damage to bits of cabin material that fell away from the post impact fire area located inflight fire in the passenger cabin of the aircraft.

Examination of the wings, empennage, and powerplants did not reveal any evidence of inflight fire.

The fuselage beneath the cabin floor and rearward of the main spar (FS-414) contains the fuel burning Janitrol heater and is also the section through which the engine fuel system cross-feed line passes. The fuel line runs within a shroud which is vented to the outside. In the event of a double leak involving both the fuel line and shroud, fuel would not be released into the fuselage during pressurized flight. The Janitrol heater is not used in flight. There was no evidence of inflight fire in this area. This is the only portion of the fuselage that has engine fuel carrying lines.

Beneath the cabin floor, from FS 335 forward encompasses the cargo compartment and spaces containing some electrical equipment, including the inverters. Sufficient unburned cargo and airplane material was recovered from this area to eliminate the possibility of inflight fire in this portion of the fuselage. Likewise, the inverters did not reveal any signs of operational over-temperature. The investigation included a check of the cargo and stowed personal luggage for hazardous materials with all indications being that none were aboard.

The remaining portion of the fuselage beneath the cabin floor between FS 335 and FS 414 is known as the electrical bay. The generator and starter circuits are brought into the fuselage by means of feed-through studs through the fuselage skin at each side of this compartment. Through stud detail design provides specific safeguards to preclude conductor to ground faults. Circuits from these studs run to main distribution panels mounted on the forward face of the main spar. Also within this compartment are most of the electrical system control and switching relays utilized in the electrical supply system, the batteries, and a freon compressor. Hydraulic lines, some of which may be pressurized, depending on system demand,

also run through this compartment. A degree of isolation of the hydraulic lines from the electrical components was attained in the design by physical separation and barriers. Fire damage in the electrical bay area was extensive, particularly on the left side. The majority of the components were destroyed or not recovered. Examination of the recovered electrical components did not reveal any evidence of a heat generating fault. One battery terminal did show an arc produced mark. No evidence of a hydraulic line leak was found. There was no consistent pattern of inflight fire discernible in this area. Smoke patterns on the main spar cap as well as soot and discoloration patterns on seat track pieces that were installed between FS 335 and FS 414 were given detailed attention. Clean fracture and scrape marks next to sooted or discolored areas and discoloration of seat track pieces on the underside, which is exposed in the electric bay, contrasted with clean upper surfaces which are in the passenger cabin but not exposed.

An inflight fire existed in the passenger-occupied portion of the cabin. The only flammable liquid carried as a part of the airplane above the fuselage floor is hydraulic fluid in a reservoir located in a compartment between the carry-on luggage rack and the lavatory. The reservoir was damaged by impact and fire and was empty. The fire damage pattern in and about the reservoir compartment did not support hydraulic fluid as a contributing factor to the fire. Another source of flammable fluid known to have been aboard the aircraft was a one-gallon can containing a commercial paint modifier. This can was recovered in the wreckage area, crushed with no evidence of fire damage to either the can or its paper wrapping.

Fire damage and smoke patterns were found in three general areas of the passenger cabin. These were (1) Beneath No. 4 window on the left side from approximately FS 388 to FS 495; (2) On the cabin side of the forward bulkhead, FS 198, on its left side; (3) On the exterior wall of the forward lavatory, right side at FS 232. There were other isolated areas of fire or soot damage throughout the cabin including the lower half of the No. 9 window, on several public address system speakers, and on some passenger seats.

Under the No. 4 window there was heavy sooting of the shear cleats of the stringer which were tightly compressed against the fuselage skin during breakup. Clean (unsooted) breaks were noted in the sooted areas under the window as well as clean areas where flush rivets had been pulled from the structure.

Two large sections of the left forward bulkhead, FS 198, had received fire damage. The vinyl material that covers the top half was missing but the backing material was not damaged while the bottom half was heavily matted with a deep soot pattern. Another piece of decorative wall material was heavily sooted and matted but the splintered edges of the plywood backing were comparatively clean. The front wall attachment bracket for the blanket rack was moderately sooted but was clean under the rotated reinforcement plate. Most of the fuselage former sections from FS 399 aft to FS 618 displayed distinct unsooted areas that were covered by blanket rack support brackets before breakup. A portion of a soundproof window[2/] was

2/ The soundproofing window is a second piece of plexiglass mounted inboard of the regular window covering the entire window opening. These soundproof windows are located at the Nos. 1 and 2 window positions and can be identified by their lack of contour and the special plastic used in them.

recovered coated on the inside with soot and a white deposit which was similar to the white smoke given off when the vinyl cover on the left forward bulkhead is burned. The plastic window material had flow marks on it which indicated that it had been heated to approximately 626°F., while in an upright position. There was also evidence of pre-impact fire in the carry-on baggage rack and other areas in the forward cabin.

The firefighting equipment aboard the aircraft was examined to see if it had been used. Fire extinguishing systems are provided for the engines, underfloor cargo compartments, the Janitrol heater, and the cockpit and cabin. Three of the four engine fire bottle discharge heads were recovered but none showed signs of having been discharged by electrical means. The forward cargo compartment CO_2 extinguisher had been fired electrically. No positive determination could be made as to whether the Janitrol heater compartment CO_2 extinguishers had been fired. One of the two cabin CO_2 fire extinguishers had been discharged and a cabin water extinguisher had been prepared for discharge; however, it had not been expended.

A flight crew walk-around oxygen bottle was recovered with the control valve open. The rubber diaphragm in the regulator had been discolored by smoke. One passenger oxygen bottle was found with the shutoff valve "open." A portion of one of the three installed flight crew full-face smoke masks was recovered but there was no evidence of its having been in use.

All three supercharger spill valve actuators were found with their actuating rods in the "supercharge spill" position. This setting would dump supercharger air overboard rather than using it to pressurize the cabin. The cabin pressure control located in the cockpit was set at the "sea level" selection and the cabin outflow valves were found in the manually depressurized position. The unpressurized flight valve electrical actuator was found in the "depressurized" position.

The interior locking mechanisms for the No. 4 and No. 9 windows on the left side were found in the unlocked position, and the captain's direct vision (DV) window was found unlocked and partially open. The copilot's DV window track and frame with attached cockpit liner showed evidence of heating and sooting. Adjacent portions of the cockpit liner that had been covered before breakup were clean. The window position at impact could not be determined. There was no evidence of an inflight fire originating in the cockpit portion of the fuselage.

The engines, underfloor cargo compartments, and the Janitrol heater are equipped with fire detection systems. The captain of the previous flight in this aircraft testified that he detected no problems with the fire warning systems when he tested them.

There is no smoke detection system other than crew sense of smell or observation of smoke in the aircraft.

In normal operation cabin air is drawn down under the cabin floor and circulated back into the cabin by the recirculating fan through ventilators in the cockpit and cabin. Any smoke generated under the cabin floor would be transferred to the cabin and cockpit within seconds where it would be seen or smelled by the crew and passengers.

1.14 Survival Aspects

This accident was non-survivable and no studies were made of the structure from that standpoint.

1.15 Tests and Research

The passenger that fell from the aircraft exited through an emergency window over the left wing. Witnesses who saw him fall said he did not strike the empennage but fell nearly straight down. An aerodynamic study as well as the body injury pattern confirmed the witness observations. He died of injuries received on impact with the ground. He had received burns on the hands, face and neck before death but had only a few carbon particles in his trachea and a carbon monoxide level of five percent in his blood.[10/] The upper portions of his clothes were impregnated with soot. There was no evidence of ground fire where the body was recovered.

The Armed Forces Institute of Pathology (AFIP) performed a number of tests of specimens from both crewmembers and passengers for the Board. Tests for carbon monoxide were not done on the flight crew due to a lack of suitable specimens. Passenger toxicological examination results were negative; no elevated carbon monoxide levels were found; no significant amount of alcohol was found; and tests for methylbromide yielded negative results. Histological examination of the seven recovered respiratory tract specimens revealed only a small number of carbon particles in each.

Federal Bureau of Investigation laboratory tests were accomplished to verify evidence of heat and smoke deposits; analyze various deposits on aircraft parts and on the free-fall victim's clothing, and evaluate possible evidence of sabotage. No residues were found to indicate that an explosion occurred aboard the aircraft. The reports did describe evidence of considerable heat or fire damage and sooting to various components within the cabin, cockpit, and under the cabin floor aft of the cargo pit and forward of the main spar.

With the Board's concurrence, British Aircraft Corporation laboratory tests were conducted on samples of aircraft structure, components, and the free-fall victim's clothing. These examinations consisted of exposure of ultra-violet light, X-ray, infra-red and emission spectroscopy, microscopic and visual observation. Their test results indicated that there was evidence of cabin fire on seats, windows, forward bulkhead trim, and the carry-on luggage rack. The sidewalls of the carry-on luggage rack had been exposed to temperatures on the order of 122°F., and the plastic material from a soundproof window had been exposed to temperatures of 626°F. They were best able to duplicate the heat damage to the free-fall victim's clothes by burning and quenching a fire of lighter fluid in a sample of the material. They did note the presence of black deposits on the bottom of seat track samples, taken from an area over the electrical bay, with none on the top of the samples. They concluded, however, that the deposits had more the characteristics of lacquer than soot.

10/ Any concentration of less than 10 percent carbon monoxide is considered negative.

The National Bureau of Standards prepared a number of electron photomicrographs of carbon specimens taken from the free-fall window and passenger's clothing, and from various components of the aircraft found at the main wreckage site, primarily from under the cabin floor between FS 317 and FS 414. They conducted tests to determine the effects of various temperatures on paint on pieces of seat track and underfloor runners taken from the aircraft wreckage. They also examined the Janitrol fire extinguisher bottle firing strip. Aluminum paint samples exposed to heat of less than 400°F. for two minutes showed no visible effects. Color changes began after exposure for two minutes at 400°F. and blistering began in two minutes at 450°F. At 900°F. the paint darkened to dark brown or black. These results were used in conjunction with the electron photomicrographs to study various components of the aircraft for evidence of fire in flight. The examination of the Janitrol bottle firing strip was inconclusive and no determinations could be made regarding the conditions under which it fractured.

The photomicrographs of the carbon specimens were forwarded to a specialist in an effort to determine the identification of the material that produced the soot found on the wreckage and the free-fall victim's clothing. The carbon deposits taken from both the free-fall items and under floor wreckage at the crash site were identified as being the produce of incomplete combustion of saturated aliphatic hydrocarbons. Examples of this type of fuel are kerosene, gasoline, paraffin, hydraulic fluid, lighter fluid, and naphtha. Of these examples, only kerosene, hydraulic fluid, and lighter fluid were known to be aboard the aircraft. The lighter fluid was not known to be aboard in sufficient quantity to produce the amount of fire experienced. Kerosene in the form of engine fuel and hydraulic fluid were aboard the aircraft in quantity.

Additional studies of the fire damage were made by a specialist from the Massachusetts Institute of Technology and tests to determine the effect of heat on aluminum surfaces were made under his direction. These tests, made under laboratory conditions, included the exposure of numerous painted and unpainted specimens to open flames in one series and to oven heating in another series. In the open flame tests, kerosene, hydraulic fluid and turbine engine oil were used with both oxidizing and reducing atmospheres to produce soot deposits on the test specimens. In these tests it was found that soot was deposited only on those portions of specimens in the line of flame impingement. Scratches in areas of light sooting remained clean and bright, but became dark with progressively heavier deposits of soot. The soot build-up in scratches and cuts was also a function of flame impingement angle. In another series of tests, individual specimens were dipped in one of the above-mentioned fluids prior to insertion in the oven. They were retained in the oven for five minutes at temperatures ranging from 450°F., to 1000°F. Both oxidizing and reducing atmospheres were used. In these tests painted aluminum surfaces darkened progressively to 800°F. Above this temperature the dark coloring disappeared and the surfaces became silver gray. Between 700° and 800° the fluid deposits burned, leaving black deposits on all surfaces. At lower temperatures, scratches and edge cuts on specimens remained bright, independent of the surface discoloration caused by the fluids and other deposits on surface finishes on the specimens. From these tests and comparison with the underfloor wreckage of N7405, he concluded that there was no positive evidence of an underfloor fire prior to impact.

1.16 Additional Information

Investigation of insurance purchased by passengers and crewmembers disclosed no suspect areas. Nothing unusual was noted regarding the passengers or baggage that went aboard the aircraft and there was no known hazardous cargo aboard the aircraft.

2. ANALYSIS AND CONCLUSIONS

2.1 Analysis

Crew training and certification were not considered to have a causal relationship to this accident. The weight and c.g. of the aircraft was within limits at takeoff and computed to have stayed within limits until the crash. There was no evidence that the weather, sabotage by explosion, any failure of the powerplants, or the primary aircraft structure played a part in this accident. The Air Traffic Control handling of the aircraft was routine throughout the flight. There is no evidence of improper aircraft maintenance or that the aircraft was not airworthy at the time of its departure from Washington.

There was no indication of any difficulties aboard the aircraft until after it passed Holston Mountain VOR. Having passed the VOR, the crew began a normal en route descent in VFR conditions that would have brought them into the Knoxville area at a reasonable altitude to maneuver for a landing. Their descent was probably normal, i.e., approximately 1,000 feet per minute until they canceled their IFR flight plan at 1802:45. There was nothing in their transmissions to indicate they were having any difficulty at that time. The aircraft should have been at approximately 11,000 feet and about 24 miles southwest of Holston Mountain when they canceled their IFR flight plan.

At some time during the descent, the aircraft deviated to the south of V16 but was proceeding approximately parallel to the airway. No reason can be assigned to this deviation. The first witness believed to have seen the aircraft was 38 nautical miles southwest of Holston Mountain. He estimated the aircraft to be 4,000 feet (approximately 5,500-6,000 feet m.s.l.) above the terrain and the aircraft appeared to be normal at this time. The aircraft appeared to be following a nearby river, in a descent, and was about 8 miles south of the airway centerline. Three miles farther along the flightpath, at approximately 1810, the aircraft was observed about 500 feet above the ground. The aircraft continued to operate at very low altitudes and well to the left of the airway from this point on to the crash. The average rate of descent from initiation to level off at an estimated 500 feet above the ground was about 1,200 ft./min. and the average ground speed was 174 knots from initiation of the descent to impact. This indicated that the flight's airspeed was reduced from a cruising speed of 237 knots to some lower value and that the descent was continued to an altitude above the ground lower than that normally utilized in transport operation.

It is believed that the crew discovered a fire sometime during the period between cancelling their IFR and before being observed in a descent about 4,000 feet above the ground.

As previously stated there was extensive fire damage in the electrical bay. However, this fact alone cannot be considered significant. This area in the

Viscount, as in the majority of low wing configured aircraft, is in close proximity to and between the fuel tanks. Thus, in a breakup, this is a likely area to receive a substantial quantity of the spilled fuel and in turn to be heavily damaged by post impact fire. This fire damage pattern has been observed in many accidents where post impact fire occurred. The somewhat conflicting soot and discoloration patterns observed on certain isolated pieces from the electric bay area dictated further considerations with respect to inflight fire. The only likely source of overtemperature in this compartment is a gross electrical fault to ground. The emergency procedure executed by the crew does not support a gross electrical system malfunction. An electrical source smoke or fire emergency is combated by turning the emergency power switch on and placing the battery master switch and generators off. Equipment that was operating at impact and DME operation to five miles before impact shows this particular emergency procedure had not been executed. Historically, under-the-floor fires that have persisted to a catastrophic stage have burned through the relatively light fuselage belly skin, have been observed by witnesses when present, and have left a path of partially burned debris on the ground. This did not happen in this case. Finally, to involve the hydraulic fluid in an electric bay fire would have required two essentially simultaneous failures, fluid leakage and an electrically induced overtemperature or sparking situation for ignition. Physical evidence fails to support either of these occurrences. Although the object of a great amount of investigative effort, the origin of the fuselage fire being in the electrical bay could not be established on the basis of the available evidence.

Burns on the free-fall victim and fire-damaged passenger cabin material found remotely from the primary impact and ground fire area established conclusively that there was an inflight fire in the passenger cabin. Evidence of use of the portable cabin CO_2 extinguisher and the attempt to use the portable water extinguisher, together with the open valve of a flight crew walk-around oxygen bottle are suggestive of the first officer having gone back to the cabin to fight the fire a few minutes before the crash. Opening the outflow valves, the left side cockpit window, and emergency exits was probably done in connection with smoke evacuation efforts.

Spill valves to "spill" and discharge of CO_2 into the baggage compartment are procedural items to combat a cargo compartment fire and were accomplished. It is recognized that accomplishment of these two items is not compatible with the conclusion that an inflight fire did not originate beneath the cabin floor. Any attempted explanation must of necessity be conjecture. However, it is considered likely that as the situation aboard the aircraft became very grave, precise checklist items were supplemented by any action that offered even a remote possibility of being helpful.

The combustible material and source of ignition that started the fire are not known. Although attempts to determine if any passenger had carried any hazardous material aboard the aircraft did not reveal this had occurred, the possibility cannot be ruled out. Such a material, either innocently or with malicious intent may have been in the possession of a passenger. Leakage or spillage of a flammable fluid with accidental or intentional ignition is a possible situation. Substantial aircraft cabin fires are such a rare occurrence that a most unusual and possibly not readily conceivable circumstance is visualized in this instance.

In examining the final maneuver and crash, it is apparent that the aircraft was not under control of the crew. There are a number of hypotheses that can be advanced to explain this loss of control including: distraction of the pilot; failure of the flight control rods due to fire damage; incapacitation of the pilot by heat and/or smoke, a shift of loading caused by the passengers moving to the aft end of the cabin; an overt act by some person aboard the aircraft, or any combination of these.

There is no probative evidence available to the Board on which to base a determination as to the cause of the final maneuver.

2.2 Conclusions

A. Findings

1. The flight crew and stewardesses were properly qualified and certificated.

2. The weight and c.g. of the aircraft were within limits at takeoff from Washington, and on the basis of known facts, computed to be within limits at the time of the crash.

3. Weather was not considered to be a factor in the cause of this accident.

4. There was no powerplant or airframe failure prior to the accident.

5. There were no known aircrew errors.

6. There was an inflight fire in the passenger cabin.

7. Firefighting and smoke evacuation procedures were carried out by the crew.

8. The free-fall victim was exposed to high heat and heavy soot before he left the aircraft through the No. 4 window. He did not strike the tail, but received fatal injuries due to impact with the trees and ground.

9. Sooting by inflight fire was caused by incomplete combustion of an aliphatic hydrocarbon fuel.

10. The Board is unable to identify the source of fuel, the ignition point of the fire, or the cause of the final maneuver.

B. Probable Cause

The Board determines that the probable cause of this accident was an uncontrollable inflight fire of undetermined origin, in the fuselage, which resulted in a loss of control of the aircraft.

3. RECOMMENDATIONS

Copies of recommendations with the corrective action taken are attached. Attachment No. 1 deals with the installed flight recorder and Attachment No. 2 the forward cargo compartment fire extinguisher.

BY THE CIVIL AERONAUTICS BOARD:

/s/ CHARLES S. MURPHY
Chairman

/s/ ROBERT T. MURPHY
Vice Chairman

/s/ G. JOSEPH MINETTI
Member

/s/ WHITNEY GILLILLAND
Member

/s/ JOHN G. ADAMS
Member

COPY

Attachment #1

FEDERAL AVIATION AGENCY
Washington, D. C. 20553

January 2, 1964

In Reply
Refer To: FS-110

Mr. Leon H. Tanguay
Director, Bureau of Safety
Civil Aeronautics Board
Washington, D. C. 20428

Dear Mr. Tanguay:

This is to acknowledge your letter of December 17, 1963, reference B-1-96, regarding impact damage to the Lockheed 109-C flight data recorder installed in the PAWA 707, N709PA aircraft which crashed near Elkton, Maryland, on December 8, 1963.

Your recommendations are being studied and we will advise you further on this matter.

Sincerely yours,

/s/ W. Lloyd Lane

George S. Moore
For Director
Flight Standards Service

Attachment #1

COPY

FEDERAL AVIATION AGENCY
Washington, D. C. 20553

February 27, 1964

In Reply
Refer To: FS-110

Mr. Leon H. Tanguay
Director, Bureau of Safety
Civil Aeronautics Board
Washington, D. C. 20428

Dear Mr. Tanguay:

This refers to your letter of December 17, 1963, reference B-1-96, regarding impact damage to the Lockheed 109-C flight data recorder installed in the Pan American World Airways B-707, N709PA, aircraft which crashed near Elkton, Maryland, on December 8, 1963, and our letter of acknowledgment dated January 2, 1964.

With respect to the Lockheed 109-C recorder, we are exploring what action can be taken to improve the crash resistance properties of this recorder. Consideration is being given to modifications for strengthening the record holder and the latches. If such modifications can be reasonably accomplished, we will study the possibility of a retrofit program by the airlines.

In addition, a project has been established to revise Technical Standard Order C51 to improve the performance standards related to crash resistance of recorders. We anticipate a notice of proposed rule making on this project by October 1, 1964.

The Agency also has two other related programs under way which can be expected to provide further useful information. One of these is an evaluation of tail-mounted recorders. The results will serve as a basis in considering future revisions to the installation requirements. The other program involves the development of an improved flight data recorder. It includes consideration of the greatly increased crash survivability capabilities which you recommend in this and previous correspondence.

We hope that this explains adequately the Federal Aviation Agency activities in the area of flight data recorders.

Sincerely yours,

/s/ Edward C. Hodson

George S. Moore
For Director
Flight Standards Service

COPY

Attachment #1

CIVIL AERONAUTICS BOARD
BUREAU OF SAFETY

July 17, 1964

Mr. George S. Moore
Director
Flight Standards Service
Federal Aviation Agency
Washington, D C 20553

Dear Mr Moore

This refers to your letter of February 27, 1964, which states the action being taken by the Federal Aivation Agency on the Board's letter dated December 17, 1963, relative to specific recommendations for improving the accuracy and the survivability of flight recorders.

As you know, the Lockheed 109C flight recorder installed in the United Air Lines Viscount 745, N7405, which crashed near Newport, Tennessee, on July 9, 1964, was very severely damaged by the ground impact and the ensuing fire. The mechanical damage was total demolishment of the case and the internal mechanism, and the ensuing fire consumed the accident portion of the flight record as well as fusing the tape on the spools.

In view of the interest being generated following the Newport accident, we would appreciate being advised as soon as possible as to the current status of the FAA actions outlined in your above letter.

Sincerely yours,

/s/ Leon H Tanguay

Leon H. Tanguay
Director, Bureau of Safety

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Attachment #1

FEDERAL AVIATION AGENCY
Washington, D. C. 20553

August 7, 1964

Mr. Leon H. Tanguay
Director, Bureau of Safety
Civil Aeronautics Board
Washington, D. C. 20428

Dear Mr. Tanguay:

This is in reply to your letter of July 17, 1964, reference B-80-96, concerning Federal Aviation Agency action on flight recorder improvements. The following outlines the current status of Agency action:

1. An airworthiness directive is being processed as a Notice of Proposed Rule Making. This AD is directed at improving crash survivability on Lockheed Aircraft Service Company Flight Recorders, Models 109C and 109D, as follows:

   a. On Model 109C, serial numbers up to and including S/N 882, and Model 109D, serial numbers up to and including S/N 135, replace the tape cassette with a Lockheed Aircraft Service Company stainless steel cassette, P/N 4024570-1.

   b. On Model 109C, up to and including S/N 889, saw off near the case the two latch clamps which are to the left of the pitot pressure line connector when facing the pitot pressure connector. File the remaining edges of the clamp to conform to the contour of the recorder case and install Lockheed Aircraft Service Company clamping ring, P/N 4024582-1.

2. AD action is being considered which will require improvements in the cassettes of the United Data Control and Fairchild flight recorders.

3. Technical Standard Order C-51, Aircraft Flight Recorders, is being revised to incorporate increased crash strength standards. Regulatory documentation leading to issuance of

Notice of Proposed Rule Making is nearing completion. We anticipate issuance of the NPRM on this subject before October 1, 1964.

4. The NPRM on the installation of the flight recorder is being finalized and is expected to be released on or about October 1, 1964. The proposed rule will require the flight recorder to be located and mounted in the airplane in such a manner that the probability of rupture of the container as a result of crash impact will be minimized. We further state that in compliance with this requirement the recorder shall be located as far aft as practicable and shall not be located aft where aft-mounted engines are likely to crush the recorder during impact.

5. In regard to our program to investigate improved recorders (24 parameters), we have received proposals from five manufacturers. We will evaluate the proposals and select those recorders considered best suitable for the program. This action is expected to be completed by November 1, 1964.

Sincerely yours,

/s/ George S. Moore

George S. Moore
Director
Flight Standards Service

COPY

Attachment #1

FEDERAL AVIATION AGENCY
Washington, D. C. 20553

In Reply
Refer to: FS-102

August 28, 1964

Mr. Leon H. Tanguay
Director, Bureau of Safety
Civil Aeronautics Board
Washington, D. C. 20428

Dear Mr. Tanguay:

This is to acknowledge your letter of August 21, 1964, reference B-80-96, regarding the status of the actions concerning flight recorder improvements.

Your recommendation that the Airworthiness Directive include reference to all modifications as an acceptable means of compliance for the Fairchild Model 5424 recorder as well as the UDC Model F-542, inasmuch as the designs are comparable, is being considered and we will advise you further on this matter.

Sincerely yours,

/s/ James F. Rudolph

George S. Moore
For Director
Flight Standards Service

COPY

Attachment #1

CIVIL AERONAUTICS BOARD
Washington, D. C. 20428

In Reply Refer To: B-80-96

August 21, 1964

Mr. George S. Moore
Director
Flight Standards Service
Federal Aviation Agency
Washington, D. C. 20553

Dear Mr. Moore:

This is in reference to your letter of August 7, 1964, regarding the status of the actions concerning flight recorder improvements.

Item No. 2 in the above mentioned letter refers to Airworthiness Directive action being considered which will require improvements in the cassettes of the United Data Control and the Fairchild flight recorders. We have been apprised of the proposed modifications to flight data recorders manufactured by United Data Control for their Model F-542. These modifications include additional recording medium protection plates against tearing and crushing, and a magazine handle latch to preclude inadvertent unlocking of the magazine. The modification improvements are covered by UDC Dwg. SK-260, revision A, dated June 19, 1964. We understand that similar modifications have not been proposed for the Fairchild Model 5424 flight recorder.

We recommend, therefore, that the AD include reference to all of the above described modifications as an acceptable means of compliance for the Fairchild Model 5424 recorder as well as the UDC Model F-542, inasmuch as the designs are comparable.

The last sentence in Item No. 4 of your letter reads, in part: ". . . the recorder shall be located as far aft as practicable and shall not be located aft where aft-mounted engines are likely to crush the recorder during impact." The following rewording is suggested as more appropriate: ". . . the record holder shall be located as far aft as practicable but shall not be located in a position where aft-mounted engines are likely to crush the record during crash impact." The above underlining is merely to point out the changes.

We would appreciate being advised as soon as possible relative to the action contemplated on the issuance of the AD.

Sincerely yours,

/s/ Leon H. Tanguay

Leon H. Tanguay
Director, Bureau of Safety

COPY

Attachment #1

FEDERAL AVIATION AGENCY
Washington, D. C. 20553

January 11, 1965

In Reply
Refer To: FS-120

Mr. B. R. Allen
Director, Bureau of Safety
Civil Aeronautics Board
Washington, D. C. 20428

Dear Mr. Allen:

This is in reply to your letter of August 21, 1964, and, in addition, confirmation of telephone information forwarded to your office regarding the latest developments on the airworthiness directives for the Lockheed Air Service, Fairchild Flight Data, and United Data Control Recorders.

The following outlines the current status of Agency actions:

a. Lockheed Aircraft Service Company Flight Recorders, Models 109C and 109D. An airworthiness directive was published in the Federal Register on July 29, 1964, as a Notice of Proposed Rule Making. An airworthiness directive has been published on December 28, 1964.

b. Fairchild Camera and Instrument Corporation Flight Recorder Model F-5424. The airworthiness directive was published in the Federal Register on November 20, 1964, as a Notice of Proposed Rule Making.

c. United Data Control Flight Recorder Model 542. The airworthiness directive was published as a Notice of Proposed Rule Making in the Federal Register on December 5, 1964.

In reference to your comments on the proposed rule for installation of flight recorders, we will consider your recommendations in our proposed rule making action now in preparation.

Sincerely yours,

/s/ George S. Moore

George S. Moore
Director
Flight Standards Service

COPY Attachment #1

FAA AIRWORTHINESS DIRECTIVE

65-1-3 Lockheed Aircraft Service Company Amdt. 39-17 Part 39 Federal Register December 29, 1964. Applies to Models 109C and 109D Flight Recorders Installed in Aircraft as Required by Applicable Operating Rules.

Compliance required within eight months after the effective date of this AD, unless already accomplished.

To improve the crash survivability of the flight record, modify the Lockheed Aircraft Service Company flight recorder Models 109C and 109D as follows:

(a) On Model 109C serial numbers up to and including Serial Number 882 and Model 109D up to and including Serial Number 135, replace the tape cassette with a Lockheed Aircraft Service Company stainless steel cassette P/N 4024570-1.

This directive effective January 27, 1965.

Revision Lockheed Aircraft Service Company Amdt. 39-135 Part 39 Federal Register September 11, 1965.

Revise AD 65-1-3, Models 109C and 109D flight recorders, by deleting paragraph (b).

This amendment effective September 11, 1965.

Revision Lockheed Aircraft Service Company Amdt. 39-196 Part 39 Federal Register February 19, 1966.

Revise AD 65-1-3, Models 109C and 109D flight recorders, by:

1. Changing the compliance statement to read.

Compliance required as indicated, unless already accomplished.

2. Changing paragraph (a) to read:

(a) Within eight months after the effective date of Amendment 39-17 (29 F. R. 18477), on Model 109C, serial numbers up to and including Serial Number 882 and Model 109D up to and including Serial Number 135, replace the tape cassette with a Lockheed Aircraft Service Company stainless steel cassette P/N 4024570-1.

3. Adding the following new paragraph (b) and the following parenthetical reference statement to read:

(b) Within eight months after March 24, 1966, on Model 109C, up to and including Serial Number 889, saw off near the case the two latch clamps which are to the left of the pitot pressure line connector when facing the pitot pressure line connector. File the remaining edges of the clamp to conform to the contour of the recorder case, and install Lockheed Aircraft Service Company clamping ring, P/N 4024582-803, or an equivalent approved by the Chief, Aircraft Engineering Division, FAA Western Region.

(Lockheed Aircraft Service Company Bulletin No. 31-12 dated April 1, 1965, covers this subject.)

This amendment effective March 24, 1966.

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Attachment #2

CIVIL AERONAUTICS BOARD
BUREAU OF SAFETY

October 9, 1964

Mr. George S. Moore
Director
Flight Standards Service
Washington, D.C. 20553

Dear Mr. Moore:

During the Board's investigation of the recent accident near Parrottsville, Tennessee, on July 9, 1964, involving a United Air Lines Vickers Viscount, N7405, several static and inflight tests were conducted on the fire extinguishing system for the underfloor cargo compartment using similar aircraft. The results of these tests pointed out certain discrepancies which could seriously affect the safety of the aircraft and passengers.

At least fifteen fire extinguishers, Pyrene Duo Head Model DCD-10 were discharged during the static and inflight tests. This extinguisher is located behind the first officer on the right hand side of the flight deck companionway. Connection of the extinguisher to the underfloor cargo compartment spray tube assembly is accomplished by means of a flexible hose between the bottle discharge head and a bayonet floor fitting. This arrangement allows the bottle to be utilized as a portable extinguisher should the need arise. All of the static tests were conducted with the flexible hose configuration. United Air Lines replaced the flexible hose with a rigid tube for the inflight tests.

The most serious discrepancy noted during the tests concerned spraying of CO_2 into the cockpit when extinguishers were discharged. At least five of the fifteen tests resulted in the gas escaping into the cockpit where CO_2 concentrations in the atmosphere at head level were measured at maximum values of 12 percent. This leakage occurred at the bayonet floor fitting on the flexible hose installations and at the valve in the bottle discharge head of the extinguishers with the rigid tube installation. In each of these cases very little of the CO_2 was discharged into the underfloor compartment.

A second discrepancy concerned improper installation of the metal seal diaphragm, Pyrene P/N 49/90140, which is installed in the discharge head of the extinguisher. This seal diaphragm covers the outlet port of the discharge valve and is installed prior to charging the extinguisher. Brass terminal blocks attached to each end of the seal are connected to electrical wiring in the discharge head for normal electrical discharge. When the discharge button is pressed in the cockpit current flows through the seal diaphragm which acts as a resistance and results in heating the seal. When the temperature rises sufficiently, the metal is softened and the 200 psi pressure in the extinguisher causes the seal to rupture and the CO_2 flows into the underfloor compartment.

A number of these seal diaphragms were removed from the extinguisher discharge heads during the tests and examined. Several were found to have been installed off center resulting in improper or incomplete ruptures. Photographs of representative seals are enclosed for your information. Comparison of the seal terminal blocks to their locating slots in the discharge head indicates the reason for the off-center installation. The slots are three-fourths of an inch wide while the terminal blocks are five-eighths of an inch wide. This one-eighth of an inch tolerance allows the seal to be mispositioned a critical one-sixteenth of an inch off center. The fact that mispositioning of the seal by such a small amount can result in questionable operation of the extinguisher system would indicate marginal, if not poor, design.

The Viscount Maintenance Manual contains explicit instructions for ensuring that the seal diaphragm is centered over the discharge valve opening. However, from the number of mispositioned seals noted during the tests, it is apparent that the manual instructions are not being followed.

Based on the results of the static and inflight tests as detailed in the preceding paragraphs, the Board believes that the Pyrene fire extinguishing system for the underfloor cargo compartment as installed on Viscount aircraft is not only inadequate for its intended purpose but also poses a danger to the flight crew.

Therefore, the Board recommends that the Federal Aviation Agency evaluate the design of the Pyrene Duo Head Model DCD-10 fire extinguisher system and take such corrective action as will increase its reliability and prevent release of CO_2 into the habitable portions of the aircraft.

Flight Standards Service personnel assisting in the investigation of this accident are aware of these discrepancies and will continue to receive information relative to the problem. Personnel of our Engineering Division will also be available for further consultation on this matter.

Sincerely yours,

/s/ B. R. Allen

for Leon H. Tanguay
Director, Bureau of Safety

Enclosure

COPY

Attachment #2

FEDERAL AVIATION AGENCY
Washington, D. C. 20553

In reply
refer to: FS-120

July 26, 1965

Mr. B. R. Allen
Director, Bureau of Safety
Civil Aeronautics Board
Washington, D. C. 20428

Dear Mr. Allen:

This is in answer to your letter of October 9, 1964, reference B-80-96, concerning the CO_2 fire extinguishing system on the United Air Lines Vickers Viscount aircraft. It supplements our acknowledgment letter of October 19, 1964. Your letter of November 17, 1964, and our answer of December 15, 1964, also bear, in part (as will be explained), on this same subject.

We have evaluated the design of the Pyrene Duo Head Model DCD-10 fire extinguisher system. During this evaluation particular attention was paid to the two discrepancies mentioned in your October 9, 1964, letter. The first of these, spraying of CO_2 into the cockpit when extinguishers were discharged, was the subject of your letter of November 17, 1964, and our answer of December 15, 1964. The second discrepancy was in regard to the improper installation of the metal diaphragm, Pyrene P/N 49/90140, installed in the discharge head of the extinguisher.

As a result of our investigation, we have published a proposed airworthiness directive, applicable to the Vickers Viscount Model 744, 745D, and 810 series aircraft equipped with Pyrene fire extinguishers. The proposal appeared in the Federal Register of June 29, 1965, as Docket No. 6734.

During our investigation of this subject, we worked with representatives from UAL and the Air Registration Board, as well as your own technical personnel. Several independent flight tests were conducted, and also ground (using an installed system), and laboratory tests. Reports on these tests were submitted as exhibits at the public hearing at Knoxville, Tennessee, January 11-16, 1965.

We believe that the proposed AD contains adequate instructions for eliminating the noted discrepancies. If the overhaul, inspection, and tests provisions contained therein are carried out, the leakage of CO_2 into the cockpit from the underfloor cargo compartment fire extinguishing system will be a minimum consistent with approved flight crew emergency procedures for fire protection. These procedures were listed, in part, in our letter of December 15, 1964. Subsequent to compliance with the noted proposed AD, manual discharge of the CO_2 system will not be necessary, although this mode of operation will still be availabe if desired.

All communications received on or before July 27, 1965, will be considered by the Administrator before taking action upon the proposed rule. Since few operators use the affected airplanes, we do not anticipate many comments In any event, we feel assured that our corrective action will eliminate the problems uncovered during your investigation, as stated in your subject letter

Sincerely yours,

/s/ G. S. Moore

George S Moore
Director
Flight Standards Service

COPY

Attachment #2

FEDERAL AVIATION AGENCY
WASHINGTON, D. C. 20553

December 15, 1964

In reply
refer to: FS-431

Mr. B. R. Allen
Director, Bureau of Safety
Civil Aeronautics Board
Washington, D. C. 20428

Dear Mr. Allen:

This is in reply to your letter of November 17, 1964, regarding discrepancies in the Pyrene fire extinguisher system on the United Air Lines Vickers Viscount aircraft

Our studies concerning the Viscount CO_2 system of which you were advised in our letter of October 19, 1962, have not been completed. For your information, Vickers Armstrong has notified all Viscount operators with cockpit CO_2 systems to manually discharge the extinguishing agent into the lower cargo bin.

Pending completion of our investigation, as an interim precautionary measure, we are instructing our field personnel to request all Viscount operators with this same system to take the following action:

1. Re-emphasize to their pilots the need to don smoke masks before discharging the lower cargo bin CO_2 cylinder.

2. Instruct their pilots to manually discharge CO_2 for the lower cargo compartment.

3. Notify their pilots that it is possible for CO_2 to leak into the cockpit area.

We certainly appreciate your recommendations.

Sincerely yours,

/s/ C. W. Walker

for George S. Moore
Director
Flight Standards Service

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Attachment #2

CIVIL AERONAUTICS BOARD
BUREAU OF SAFETY

November 17, 1964

Mr. George S. Moore
Director
Flight Standards Service
Federal Aviation Agency
Washington, D. C. 20553

Dear Mr Moore:

During the course of our continuing investigation of the accident involving a United Air Lines Vickers Viscount aircraft near Parrottsville, Tennessee, on July 9, 1964, it was revealed, during static and flight tests, that certain discrepancies existed in the Pyrene fire extinguisher. The most serious of these discrepancies was the spraying of CO_2 into the cockpit area when extinguishers are discharged This was determined to have been due to leakage at either the bayonet floor fitting or at the valve in the head of the discharge bottle.

This discrepancy was previously brought to your attention in our correspondence of October 9, 1964, wherein we recommended that the Administrator evaluate the design of the Pyrene Duo Head Model DCD-10 fire extinguisher system. Your letter of October 19, 1964, indicated that our recommendation was being studied.

We believe that during the period required for your study the potential hazards outlined in our previous recommendation continue to exist. Therefore, it is further recommended that all operators of Viscount aircraft having a Pyrene cylinder installation within the general cockpit area, be requested to re-emphasize the need for pilots to don smoke masks before discharging the lower cargo bin CO_2 cylinder.

In addition the operators should be informed that a CO_2 spray directed into the cockpit area could result in considerable distraction if the pilots are unaware that such an incident could occur.

Sincerely yours,

/s/ B. R. Allen

B. R. Allen
Director, Bureau of Safety

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Attachment #2

FAA AIRWORTHINESS DIRECTIVE

65-21-6 Vickers Amdt. 39-131 Part 39 Federal Register September 3, 1965. Applies to Viscount Models 744, 745D, and 810 Series Airplanes That Are Equipped With Pyrene Fire Extinguishers, Type DCD 2, DCD 2-1/4, DCD 10, or DCD 11.

Compliance required at first airplane overhaul or within six months after the effective date of the AD, whichever occurs first, unless already accomplished.

To prevent further failures of Pyrene fire extinguishers of the subject models, accomplish the following.

(a) Overhaul, inspect, and test the fire extinguishing systems that are equipped with electric discharge facility, in accordance with revised requirements in British Aircraft Corporation (Weybridge Division) Preliminary Technical Leaflets No. 256 (700 Series), No. 120 (800/810 Series), (Amendment TR 25 to Viscount Maintenance and Instruction Manuals and Amendment TR3 to the Accessories Manual cover the same subject). Subsequent overhaul of the fire extinguishing system must be carried out in accordance with these specified periods in the FAA-approved maintenance schedule.

(b) The spray ring system must be blown through with warm dry air to insure that the piping and discharge holes are free of obstructions during the overhaul of the airplane at periods specified in the FAA-approved maintenance schedule.

This directive effective October 3, 1965.